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A LEAN SIX SIGMA APPROACH TO REDUCE WAITING AND REPORTING TIME IN THE RADIOLOGY DEPARTMENT OF A TERTIARY CARE HOSPITAL IN KOLKATA

Dr (Brig). A. P. Pandit [1] | Ms. Tanima Debmallik [2]

[1] MD(HA) DNB(H&HA), Prof, Symbiosis Institute of Health Sciences, PUNE-411004.
[2] MBA (HHM), Symbiosis Institute of Health Sciences, PUNE-411004.

ABSTRACT

A Lean Six Sigma (DMAIC) approach was taken to study the issue of the imaging services cycle turnaround time (TAT) of the Radiology Department of a Tertiary care Hospital Kolkata. By conducting a Gemba Walk interview (Annexure 1) and Time motion study (Annexure 2), the entire process was mapped and areas causing delay were identified in the defining and measuring stage. Pareto analysis yielded the root causes of delay in the analysing stage. In the intervention stage practical approaches were undertaken to increase patient orientation and preparedness for the scan thereby decreasing pre-test waiting time and streamlining of operations. The reporting process ultimately aided in reduced pre-test and post-test waiting times.

KEYWORDS: Lean Six Sigma, Pre-test waiting time, post-test report generation time.

INTRODUCTION

PROJECT CHARTER (BUSINESS CASE)

The Tertiary care hospital in Kolkata is a 500 bedded multi-speciality tertiary care hospital with an advanced department of Imaging and Interventional Radiology catering to both Inpatients as well as Outpatients. The Hospital has an operating system that has set parameters for all hospital operations and processes that need to be completed within a certain amount of time. Based on this a balanced scorecard is created by the organization and different scores portray the overall performance of the hospital and the areas that need improvement.

On studying the Tertiary care hospital data of Jun to Aug 2015, it was found that one of the major areas requiring improvement was the "Services on Time" section. In the data scorecard, the parameter for CT and MRI scan report generation time was 2 hours from the time the patient left the scan room. The target set was that, at least 90% reports of CT and MRI must be generated within this time period of 2 hours. However, the data collected in May 2015 showed that the percentage of reports generated within 2 hours is only 51.1% and the overall "Services on time" score was 44.4%.

This delay in the generation of reports was leading to an increased post scan waiting time for the patient and hence the patient satisfaction was seen to decrease. In most cases the reports were given to the patients only one day after the test completion. This was not conducive for many outpatients who had come to the hospital from places outside Kolkata and also West Bengal, as their lodging and travelling charges increased due to the waiting time. Also, the billing process for Insurance patient could not be completed and they were not discharged unless completed scan plates were provided to the TPA. For this aforesaid reporting delay, the discharge process of these patients also became prolonged.

The major bottlenecks in the entire process from the time the patient entered the Radiology department and submitted the test requisition till the time the patient received the report from the reception were identified, quantified and addressed so that the overall delay could be reduced leading to more streamlined operations and increased efficiency.

PROBLEM STATEMENT

The pre-test and post-test (Report Generation) waiting time for CT scan and MRI in the Imaging and Interventional Radiology Department of Tertiary care Hospital Kolkata was noticed to be above the set parameters leading to less number of reports generated on time and decreased patient satisfaction due to prolonged waiting times.

AIM:

To reduce pre-test and post-test waiting time in the Radiology Department of a tertiary care hospital in Kolkata using a Lean Six Sigma approach.

OBJECTIVES:

- Study the applicability of Lean Six Sigma in the healthcare industry.
- Map the entire process flow with time tags from patient entry till report generation from the Radiology Department.
- Identify areas of delay.
- Identify causes of delay.
- Propose recommendations and implement them.
- Statistically find the effectiveness of the implementations.

PROJECT SCOPE:

The project attempted to find the bottlenecks in the process of scanning and reporting of CT scan and MRI for outpatients only as the data pertains to only outpatient percentages since it was a critical parameter according to the management and administration. The project had in its scope the mapping, identification and measurement of bottlenecks in the process, suggestions and recommendations of changes that was to be made and their implementation and impact assessment. The project did not have in its scope the above stated points for Inpatients.

REVIEW OF LITERATURE:

Sigma is a Greek letter of the alphabet used to describe variability, or in mathematical terms, standard deviation. Six Sigma offers a way of measuring the performance capability of existing systems or processes. It is a statistical unit of measure that reflects the likelihood that an error will occur. Six-sigma relies on rigorous statistical methods, and implements control mechanisms, in order to tie together quality, cost, process, people, and accountability. It begins with an understanding of customer requirements, and values. The six-sigma goal is to reduce both variance and control processes in order to assure compliance with the critical specifications.[1]

Six Sigma was originally a concept for company-wide quality improvement introduced by Motorola in 1987. It was further developed by General Electric in the late 1990s.[2]

From emergency room to boardroom, six-sigma can reduce variability and waste by translating to fewer errors, better processes, improved patient care, greater patient satisfaction rates, and happier, more productive employees. To achieve these goals, the DMAIC must be implemented. The DMAIC is a five-step improvement cycle with the aim to continuously reduce errors: Define the project by identifying problems, clarifying scope, defining goals, measure the current performance against requirements, gather and compare data, refine problems/goals, analyse by developing hypotheses, identifying sources and gaps. Improve by conducting experiments to eliminate root cause, testing solutions, measuring results, standardizing solutions, implementing new processes by designing creative solutions to fix and prevent problems. To control the performance of the process by institutionalizing improvements and putting a mechanism for ongoing monitoring in place

At its core, Six-Sigma revolves around the following key concepts:

1. Critical to quality: Attributes most important to the patient.
2. Defect: Failing to deliver what the patient wants. In terms of impact to the patient, a defect in the delivery of healthcare can range from relatively minor to significant. Ina worst-case scenario, the defect can be fatal, as when a medication error results in the patient's death.
3. Process capability: What the healthcare process can deliver.

4. Variation: What the patient sees and feels.

5. Stable operations: Ensuring consistent, predictable processes to improve what the patient sees and feels.

6. Design for Six sigma: Designing to meet patient's needs and process capability.

7. Lean Six Sigma: integration of Lean Thinking (that means speed and better flow of the processes by eliminating waste) and Statistical Thinking (that means understanding data, process and variation in processes).

Appropriately implemented, Six Sigma clearly produces benefits in terms of better operational efficiency, cost-effectiveness and higher process quality.[3]

Till date, six sigma projects in healthcare industry have focused on direct care delivery, administrative support and financial administration. Most projects in the healthcare industry are based on increasing capacity in X-ray rooms.

- Reducing avoidable emergency admissions;
- Improving day case performance;
- Improving accuracy of clinical coding;
- Improving patient satisfaction at emergency room (ER);
- Reducing turnaround time in preparing medical reports;

REASULTS EXPECTED ON APPLICATION OF SIX SIGMA IN HOSPITALS

- Reducing bottle necks in emergency departments;
- Reducing cycle time in various inpatient and outpatient diagnostic areas;
- Reducing number of medical errors and hence enhancing patient safety;
- Reducing patient falls;
- Reducing errors from high-risk medication;
- Reducing medication ordering and administration errors;
- Improving active management of personnel costs;
- Increasing productivity of healthcare personnel;
- Increasing accuracy of laboratory results;
- Increasing accuracy of billing processes and thereby reducing the number of billing errors;
- Improving bed availability across various departments in hospitals;
- Reducing number of post-operative wound infections and related woundproblems;
- Improving MRI exam scheduling;
- Reducing lost MRI films;
- Improving turn-around time for pharmacy orders;
- Improving nurse or pharmacy technician recruitment;
- Improving operation room throughput;
- Increasing surgical capacity;
- Reducing length of stay in(ER);
- Reducing ER diversions;
- Improving revenue cycle;
- Reducing inventory levels;
- Improving patient registration accuracy;
- Improving employee retention.[4]

In recent years, however, Lean Six Sigma (LSS), which incorporates the speed and impact of Lean with the quality and variation control of Six Sigma, has emerged as a favourite.

Radiology is a major source of revenue generation within healthcare. Insuring the referral base for a specific radiology department and service area is an important component to providing a consistent revenue stream for a healthcare facility. The important components to maintaining the referral base include 1) timely patient scheduling, 2) timely reporting of results to physicians, and 3) providing an expected level of technology.[5]

According to a patient satisfaction survey done in an Imaging and Diagnostic facility in Texas, it was found that the percentage of satisfaction was only 30%. On probing into the matter it was found that this was because the waiting time for patient was very high. The targeted area that needed to reduce the cycle time was the registration area. However with interdepartmental collaboration, patient tracking systems and Radiologist's support, the patient satisfaction percentage was increased to 98-99%. Hence waiting time must be aimed to be reduced in the imaging and Interventional Radiology department for increased patient satisfaction.[6]

In a similar project which was aimed at optimizing the process of reporting and delivering radiological examinations with a view to achieving 100% service delivery within 72 hours to outpatients and 36 hours to inpatients, a Six Sigma approach was adopted, which adopts a systematic approach and rigorous statistical analysis to analyse and improve processes, by reducing variability and minimising errors. Of all the phases making up the process, reporting (from end of examination to end of reporting) and distribution (from the report available to administrative staff to report available to the patient) accounted for 90% of process variability. It was also found that a voice recognition system was much faster than a Dictaphone for faster report delivery. The change made was adoption of the voice recognition system and optimization of scheduling of the staff to achieve a better understanding of the internal operations and have a more total quality approach.[7]

The department of Radiology at Akron Children's Hospital, US, had embarked on a Lean Six Sigma mission as part of a hospital wide initiative to show increased customer satisfaction, reduce employee dissatisfaction and frustration, and decrease costs. Three processes that were addressed were reducing the MRI scheduling back-log, reconciling discrepancies in billing radiology procedures, and implementing a daily management system. Keys to success are that managers provide opportunities to openly communicate between department sections to break the barriers. Executive leaders must be engaged in Lean Six Sigma for the company to be successful.[8]

To increase capacity and raise patient satisfaction, Carle Clinic in Illinois needed to improve cycle time for CT exams.

The solutions proposed were- Using Six Sigma and change management tools, Carle Clinic uncovered the most critical factors impacting the exam scheduling process and implemented these changes:

- Administered contrast solution earlier so patient is prepared for exam on time
- Used MRI IV start room to prep CT patients
- Expanded tech availability with chart, requisition and file room improvements

All these had the following results-

- Increased CT capacity by six exams per day
- Achieved better predictability in the process
- Increased satisfaction
- Financial potential approximately $390,000 annually

Process improvement and workflow adjustments using Six Sigma and other tools can have a measurable impact on cost and quality of services.[9]

Li Zhang, PhD, from the department of diagnostic radiology at the University Hospital of Giessen and Marburg in Germany, and colleagues noticed that IR suites are consistently viewed as “bottlenecks in patient flow” that can cause delays in treatment and lead to longer hospital stays for patients. By applying Lean Six Sigma, they found that mean cycle time had decreased 28%, from 75 minutes to 53 minutes. The cycle time of steps performed by the radiologist decreased over 20%, from 29 minutes to 23 minutes.

These changes in cycle time led directly to a change in lead time, which then led to less waiting time for patients and referring physicians.[10]

MATERIALS AND METHODOLOGY:

The Lean Six Sigma methodology used to approach the problem is DMAIC (Define, Measure, Analyse, Improve and Control). The different steps and tools used in each step have been described-

STAGE 1- DEFINING THE PROCESS

During the Define phase of a DMAIC (Define, Measure, Analyse, Improve and Control) project, the researcher is responsible for clarifying the purpose and scope of the project and for getting a basic understanding of the process to be improved. It involves the mapping of the process which is done using the tool Process Mapping which is a qualitative process.

STAGE 2 - MEASURE

The “measure” stage of DMAIC is the second stage after the process under study has been defined. Here measuring means quantifying or measuring the defects or errors or delays associated with the process. There are various tools that have been used to measure the bottlenecks associated. The “M” (Measure) in DMAIC is about documenting the current process, validating how it is measured, and assessing baseline performance.

Finally, the baseline sigma level for the overall defect rate is estimated using a sigma conversion chart, providing a relative indicator of how close the current process is to delivering zero defects. A Six Sigma process has a sigma level of six, and for all practical purposes is considered a defect-free process over the long run, provided that adequate controls are in place to maintain capability.

The tools used are Operational definitions and Time Motion study of the entire process.

STAGE 3- ANALYSE
The data collected in the measuring stage is analysed in this stage using the tools Pareto Analysis, Fishbone analysis.

STAGE 4- IMPROVE
In this stage the recommendations are described and implemented.

STAGE 5- CONTROL
In the control stage, the effectiveness of the implementations are statistically tested.

OBSERVATIONS AND RESULTS:
DEFINE STAGE Tool 1- PROCESS FLOW MAPPING
The Process Flow chart provides a visual representation of the steps in a process. A Process Map is detailed flow diagram of the process using symbols that dig further into the nuances of a process to get a better understanding of it in terms of –

- Which steps precede which ones
- Who are the responsible personnel
- Where the process begins and ends
- The flow of events

The purpose is to visually represent the process as it is in reality. The key to getting a clear preview of the process is to actually observe it and interview the responsible personnel in the actual work environment. This is a valuable learning experience and I could quickly gain insight about the actual flow.

The process in Radiology Department takes the following stepwise pathway:
- Patient enters the Radiology Department either from one of the OPDs or from outside.
- For all tests except MRI, billing is done at the Reception. On paying the required amount of money through cash or card, the patients' test requisition number and patient details sheet is generated along with the billing invoice.
- The patient takes this Invoice and Requisition and goes to the Nursing station in the Patient screening area where the Consent form is filled by him. This consent form and requisition document is given to the nurse who gives it to the Technician in the console room.
- On arrival of the patient the technician updates patient status to "patient arrived" in the HIS.
- The patient is screened for proper clothing and food intake and based on that pre test preparation is initiated by the nurse and the technician.
- Once the patient is prepared (dress changed, water intake proper, channelling for contrast studies- for CT), patient is put onto the scan bed in the scanning room and settled there in the proper posture with the proper aids as required by the test.
- The technician comes to the console room and performs the test.
- After patient physically leaves the scan room, technician sends the Requisition and Consent to the Radiologist.
- Radiologist sees the scan through PACS and Info View and does the reporting on paper.
- This paper is sent to the MT room for typing.
- Medical Technician types and enters in the HIS and sends back the typed final version for Radiologist's signature.
- Radiologist signs off and the final report is collected by the technician. The plates are also collected by the technician.
- The CD of the scan images, the signed off report and the scan plates are sorted out by the technician.
- The final report envelope is sent to the reception for collection.
- In case of a MRI scan, the billing is done after the patient physically leaves the scan room.
- The process flow is only for Outpatients. The inpatients process flow is beyond the scope of this project and hence has not been mapped.
- A Swim line process flow chart gives a pictorial representation of the above stated process.

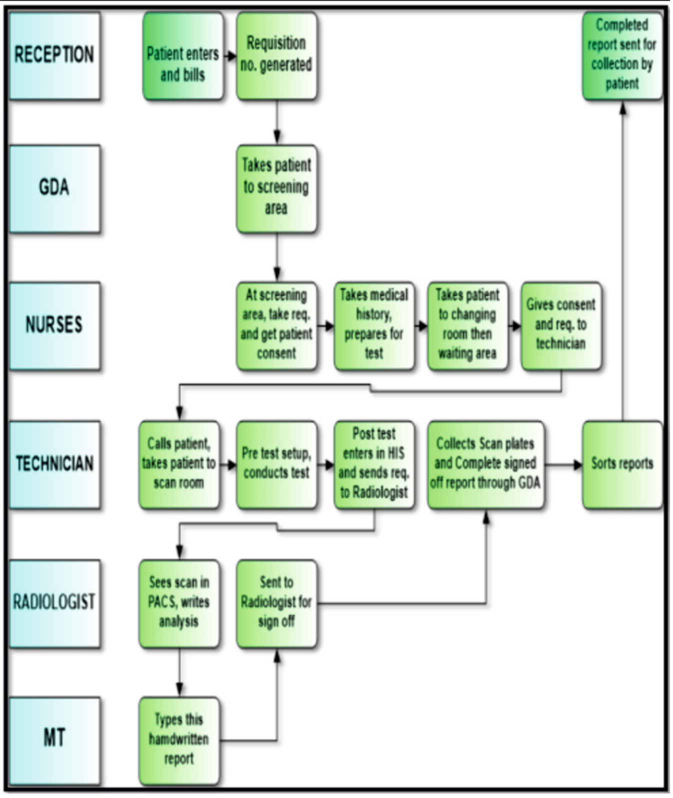


Figure1- Swim line process chart for operations in the Radiology CT/MRI Section

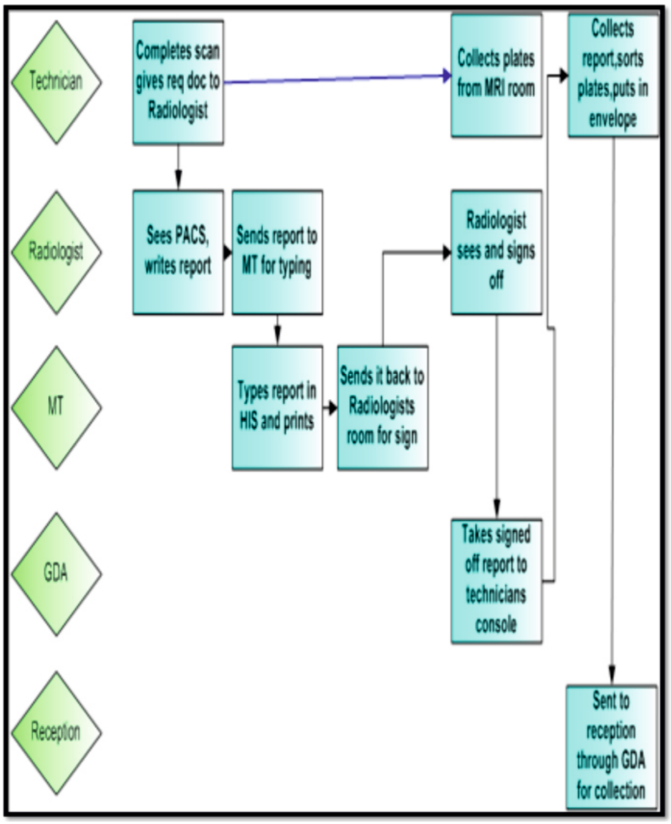


Figure 2- The above image shows the process flow in details from the commencement of the scan till the reports being sent to the reception for collection.

MEASURE STAGE TOOL 1- OPERATIONAL DEFINITIONS WITH DATA COLLECTION PLAN
One of the major milestones in a Lean Six Sigma or Six Sigma project is the drafting of the data collection plan along with the operational definitions. The Data Collection Plan is said to be a documented procedure for standardized and efficient data collection of the process. An operational definition, when applied to data collection, is a clear, concise detailed definition of a measure. The need for operational definitions is fundamental when collecting all types of data.

The following table shows the Operational Definitions and the Data Collection Plan-			
Metric	**Definition**	**Collection source**	**Interdependencies**
1. Requisition	The date and time when the OPD patient enters the Radiology department and pays for the test and requisition number is generated and reflected in the HIS	HIS, Reporting room/ Consoles	1.On HIS data 2. Unless Requisition is obtained, technician cannot begin the test even if patient is waiting.
2. Prep time/ Waiting time	Time between requisition end and before patient moves inside the test room.	Structured observation as given in annexure	Tests like CT require prep time of 60 mins average. This time is often prolonged due to delay in previous patient to physically move out of the test room.
3. Patient goes inside scan room	The point in time when patient physically enters the scan room	Structured observation as given in annexure	Patients who can walk move faster, patients seriously ill or in wheelchairs need assistance and take more time.
4. Scan starts	The scanning process starts	Structured observation as given in annexure	
5. Scan ends	The scanning process ends	Structured observation as given in annexure	
6. Patient leaves	Patient physically moves out of the scan room	Structured observation as given in annexure	
7. MT receives the report	MT receives the report after it has been done by the Radiologist for typing it	Structured observation as given in annexure	
8. Typing commencing and completion	The time at which typing by MT starts and ends	Structured observation as given in annexure and HIS	
9. Signoff	Typed, corrected report signed off by the Consultant Radiologist	Structured observation as given in annexure	
10. Post test waiting time	The duration of time after patient physically leaves the scan room till his/her report is generated.	Analysis of data collected from the structured observation.	The longer the final report generation takes, the longer is this time duration.
11. Report generated	The time when report is typed, signed off by the Radiologist and is ready.	Reporting room from Info Vision software that records reporting time.	
12. Delivered at reception	The time at which the report is sent to the reception after assembly by technician	Structured observation as given in annexure	

The following table depicts the overview of Data Collection Plan that is common for all metrics being measured-	
CRITERIA	**DETAILS ABOUT THE CRITERIA**
Sample size	A convenient sample of 200 total outpatient CT/MRI cases.
Sampling frequency	From 23rd June 2015 to 4th August 2015
Sampling strategy	100 outpatient cases- For Time motion study from patient requisition to the time report is made ready by the MT and sent to reception. 100 outpatient cases- for post implementation studies.
Measurement method	HIS aided and self-measured real time observations. The metric wise measurement method is stated in the next table.
Observations recording tool	Initially all observations are recorded in a structured questionnaire format (Gemba walk sheet) and then entered in MS Excel for analysis.

In the Time motion study, the aim was to determine the time required for performing each step as depicted in the process map in the previous Defining stage and find out the areas that require the lean treatment. With the help of the Time Motion study, the following observations were made.

OBSERVATIONS

Based on the data collected through the Time Motion Study using Gemba Walk Questionnaire, the following data has been collected-

STEP	SOURCE OF DATA	AVERAGE TIME REQUIRED
Test Requisition time	Radiology HIS	This is the starting point T1
Patient enters scan room	Physical observation	This is T2
PRE TEST PREP TIME	T2-T1	41 mins
Scan starts	Physical observation/plate time	T3
Scan ends	Physical observation/plate time	T4
TOTAL SCAN TIME	T4-T3	15 mins
Patient leaves the room	Physical observation	5 mins (T5)
Report made ready by MT	Radiology HIS	T6
POST TEST REPORTING TIME	T6-T5	99 mins

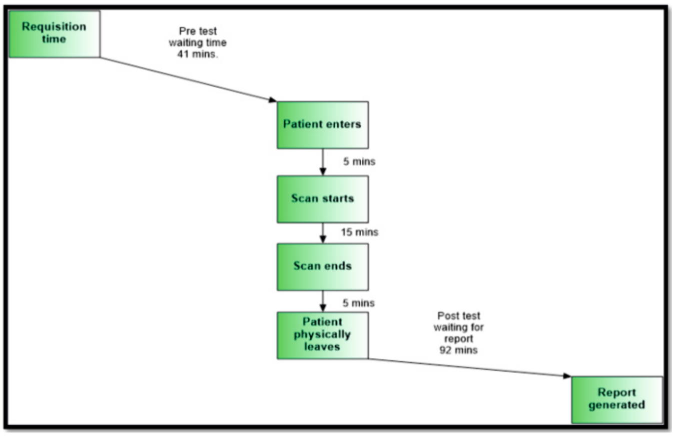
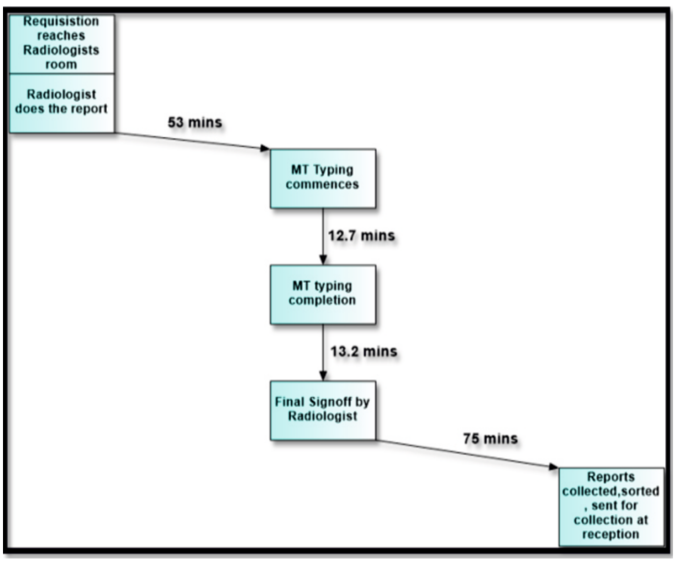


Figure 3- This figure summarizes the time taken for performing different steps as defined in the process flow map.

The Post-test waiting time was also broken up into different steps to collect data on time required by each step and the following is the data collected.

STEP	SOURCE OF DATA	AVERAGE TIME REQUIRED
Radiologist receives the Requisition	Physical observation	This is the starting point T1
Report written by the Radiologist reaches the MT	Physical observation	This is T2
RADIOLOGISTS REPORTING TIME	T2-T1	53mins
MT Typing commences	Physical observation	T3
MT Typing completed	Radiology HIS	T4
TOTAL TYPING TIME	T4-T3	12.7 mins
MT Typing completed	Radiology HIS	T4
Final signoff by Radiologist	Physical observation	T6
RADIOLOGISTS SIGNING OFF TIME	T6-T4	13.2 mins
Final signoff by Radiologist	Physical observation	T6
Reports, plates assembled by technicians and sent to reception for collection	Physical observation	T7
TECHNICIANS ASSEMBLING AND MAKING FINAL REPORT READY	T7-T6	75 mins



CALCULATION OF DEFECTS PER MILLION OPPORTUNITIES AND BASE LEVEL OF SIGMA

Formula- **Number of defects x 1000000/**

No. Of Units x No. Of opportunities

Here,

No. Of defects was the total number of CT/MRI reports that are generated beyond the target time i.e; 2hours after the patient physically left the scan room= 35 out of 100 cases observed.

No. Of units was the total number of delayed reporting that can occur in the present project scenario= 100

No. Of opportunities depict the total number of opportunities to make an error during the present project scenario= 100

Hence, DPMO= **35 X 1000000/ 100 X 100 = 3500**

From the Yield to Sigma table, it was found that the ***level of Sigma corresponding to DPMO 1000000 is 2.6 to 2.7.*** For the POST TEST WAITING (REPORTING TIME).

From literature review it was found that this range of Sigma is the basic and general level for most industries and processes.

Hence, seeing the Sigma value calculated, we inferred that there was room for improvement in the

Formula- **Number of defects x 1000000/**

No. Of Units x No. Of opportunities

Here,

No. Of defects was the total number patients waiting pre-test beyond the target time i.e. 40mins after the patient was Billed for the test= 41 out of 100 cases observed.

No. Of units was the total number of patients waiting beyond 40mins in the present project scenario= 100

No. Of opportunities depict the total number of opportunities to make an error during the present project scenario= 100

Hence, DPMO= **41 X 1000000/ 100 X 100 = 4100**

From the Yield to Sigma table, it was found that the ***level of Sigma corresponding to DPMO 1000000 is 2.6 to 2.7.*** For the PRE- TEST WAITING TIME.

From literature review it was found that this range of Sigma was the basic and general level for most industries and processes.

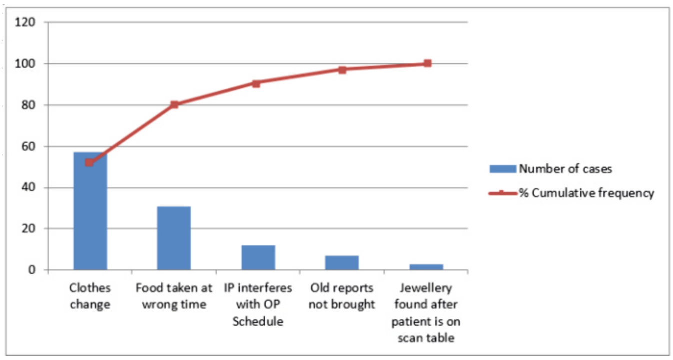
Hence, seeing the Sigma value calculated, we inferred that there was room for improvement in the

From the above Observations, it was clear that the major areas that required maximum time were the Pre-test waiting time and the Post-test report generation time. By calculating the Base Sigma level for both the waiting times, based on the number of times patients had to wait beyond set parameters of time it was observed that the Sigma Level was 2.6- 2.7 whereas the target value should be 6. Hence there is room for improvement in this entire process once the causes of delay are identified.

IDENTIFYING THE CAUSES OF DELAY

In this section we found out which were the causes that contributed to 80% and above in increasing the pre-test and post-test waiting times, using Pareto Analysis

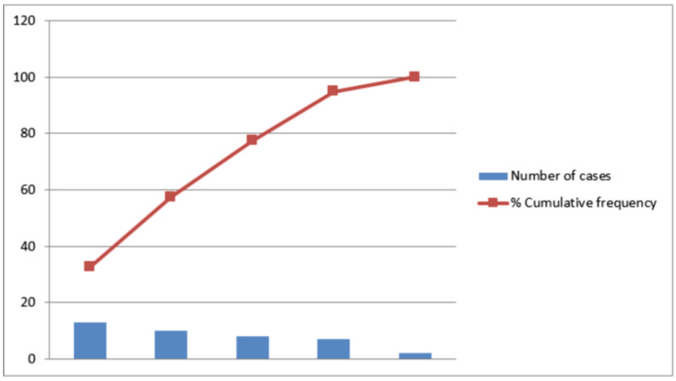
PARETO ANALYSIS FOR CAUSES OF PROLONGED PRE TEST WAITING TIME (WAITING TIME)



From the above Pareto Chart it was analysed that the main reasons for delay were the clothes changing process that happened because of the wrong make of clothes being worn by patients while coming for the CT scan and food intake at the wrong time. It was required by the patient to wear simple cotton clothes with less or no buttons and no sequin work. However this was not followed and the reason for that was that the patient was not informed about it. Also for all contrast studies it was required that, the patient to be on fasting for 4-6 hours prior to the test. Hence if the patient came at 9 am and was prescribed to do a contrast study but just had his/her breakfast, then he had to wait for 4 hours in the waiting area before the test was done on him. This was mostly because proper information was not given to patient party about these prerequisites of performing a CT scan. 80% delay was caused due to the two above stated reasons as could be seen from the Pareto chart. Hence if these can be targeted and reduced, majority of the delay could be removed.

PARETO ANALYSIS FOR CAUSES OF PROLONGED POST TEST WAITING TIME (REPORTING TIME)

CAUSES OF DELAY	NUMBER OF CASES	CUM.FREQ	%CUM.FREQ
Radiologist performing procedure	13	13	32.5
PACS server down	10	23	57.5
Requisition and patient details not sent to Radiologist immediately after scan completion, they are allowed to accumulate	8	31	77.5
Technician does not collect signed off reports and plates on time	7	38	95.0
Radiologist does the report but it does not reach MT room on time	2	40	100.0



From the above Pareto Chart, it was analyzed that the major causes of delay in the reporting waiting time were the Radiologists were engaged in procedures (CT Guided Biopsy, etc.) which in turn caused an accumulation of reports that needed to be done by them and thereby caused delay of the entire process.

The other main cause was the PACS server being down and thereby not allowing the Radiologist to make the report without the plates being printed which again delayed the entire reporting cycle.

Altogether it was observed that the reporting cycle was not streamlined and the personnel involved were not assigned specific responsibilities as to when the requisition and patient details were to be taken to the Radiologist and when and who was responsible for collection of reports to be typed and completed reports that are signed off to be collected from the Radiologists room.

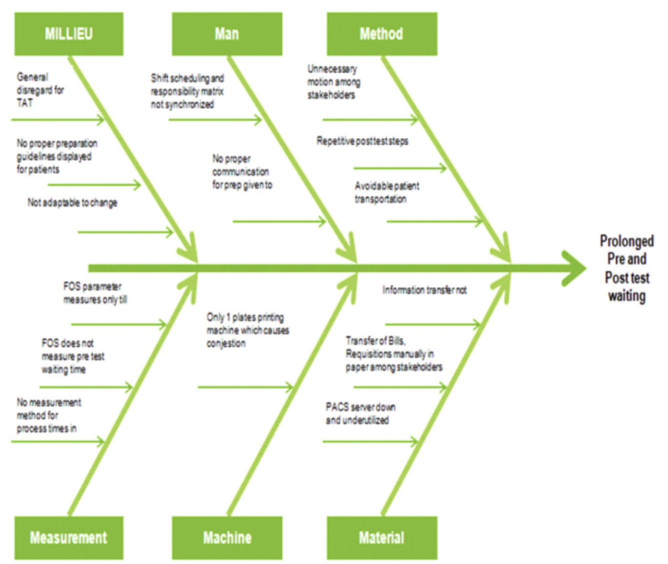


Figure 5- A Fishbone Diagram to show the causes of delay.

Causes were grouped into major categories, which were classically defined as the 6 Ms: Man , Methods (processes), Machines (technology), Materials (raw materials, information, and consumables), Measurements (inspection), and Milieu/Mother Nature (environment).

STAGE 4 – IMPLEMENTATION

Based on the data given in the previous pages, two new ideas were implemented-

1. A Written Communication System for patients- This was done to increase the patient information regarding how to prepare for the tests so that patient orientation increases and pre-test waiting time was also saved. A printed sheet (Annexure 2) containing the detailed test preparation and general instructions were given to the patients at the time of billing. Standees containing the same information were put up in all OPDs.

2. Clustered Seating Arrangement- The Medical Technologists(MT) were placed in one room marked REPORTING ROOM and the Radiologists were seated in their respective rooms. Hence the technician after the scan completion had to take the requisition form to the Radiologist, who would do the report, and then this report would go to the Reporting room for typing by the MT and then again after typing completion would have to be brought to the Radiologists room for corrections and final signoff. The new seating arrangement proposed a Clustered seating. The arrangement was made to create two clusters- CLUSTER 1 and CLUSTER 2.

CLUSTER 1- It was beside one of the USG rooms. It had catered for 3 Radiologists and 2 MTs (2 Shifts).

CLUSTER 2- The same previous Reporting room consisting of 1 MT and 1 Radiologist.

RESULTS OF IMPLEMENTATIONS-

After the implementations were made, the following results were observed-

1. Average Pre-test waiting time before implementation= 41 mins

2. Average Pre-test waiting time after implementation= 18 mins

NULL HYPOTHESIS- there is no significant difference between the pre-test waiting time before and after the implementation.

ALTERNATE HYPOTHESIS- there is significant difference between the pre-test waiting time before and after the implementation.

CALCULATIONS USING MS EXCEL-

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	101	1853	18.34653	167.6287
Column 2	101	4237	41.9505	1207.488

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	28135.92	1	28135.92	40.92152	1.1E-09	3.888375
Within Groups	137511.6	200	687.5581			
Total	165647.5	201				
Table F Value- 3.84						
Calculated F value- 40.9						

Since the calculated value was higher than the ANOVA table value (Annexure 3), we reject the null hypothesis.

Hence there was significant difference between the two pre -test waiting times. Hence the implementation of establishing a written communication to the patients regarding test preparation showed a positive result.

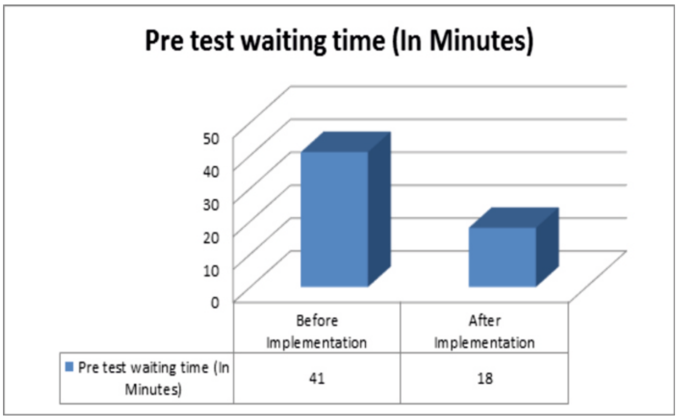


Figure 6- This figure graphically shows the difference in the pre-test waiting times before and after the implementations.

1. Average post-test report generation time before implementation= 99 mins

2. Average post-test report generation time after implementation=51 mins

NULL HYPOTHESIS- there was no significant difference between the Post-test Report generation time before and after the implementation.

ALTERNATE HYPOTHESIS- there was significant difference between the Post-test Report generation time before and after the implementation.

Anova: Single Factor
SUMMARY

Groups	Count	Sum	Average	Variance
Time after Impl.	100	5131	51.31	1377.852
Time before Impl.	100	9982	99.82	4272.533

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	117661	1	117661	41.64707	8.23E-10	3.888853
Within Groups	559388.2	198	2825.193			
Total	677049.2	199				
Table value of F=3.88						
Calculated value=41.6						

Since the calculated value was higher than the ANOVA table value (Annexure 3), we rejected the null hypothesis.

Hence there was significant difference between the two Post-test report generation times. Hence the implementation of Clustered seating showed a positive result.

5.Reports generated within set time period before implementation= 51% (May 2015)

6.Reports generated within set time period after implementation= 95% (July 2015)

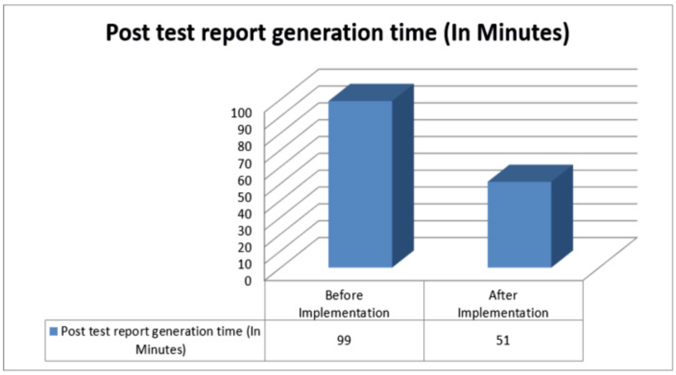


Figure 7- This figure graphically shows the difference in the post test report generation times before and after the implementations.

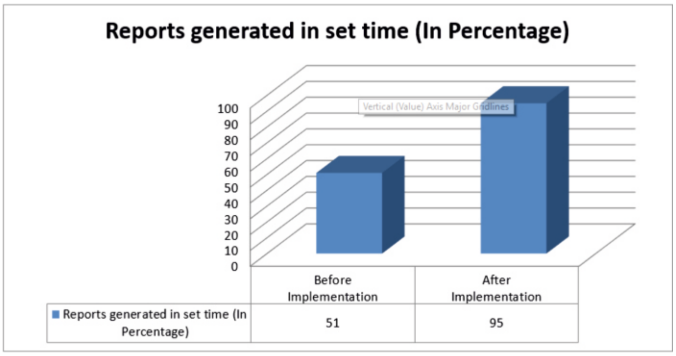


Figure 8- This figure graphically shows the difference in the percentage of reports generated on time (Within 2 hours of patient leaving the test room as defined in FOS) before and after the implementations.

CONCLUSION

The objective was to identify the areas that take up the maximum amount of time in the Radiology Department of a super speciality Tertiary care Hospital, in Kolkata. Two areas were the bottlenecks for the entire process flow of the department. The areas identified were the Pre-test waiting time period when the patient has paid for the test and received the requisition document and he or she is waiting for the test to commence; and the other area was the Post-test waiting time period when the patient is waiting for the test report. Based on the data collected it was seen that the overall Sigma level for the process from the patient entering the department till the time his test report was generated was low (2.6-2.7) when the general accepted value for any industry is 6. Hence it is concluded that there is room for improvement. On analysing the causes of delay it was found that the lack of information given to the patient regarding preparations for the test was the major cause of delay and increased pre-test waiting time. The major contributor for increased post-test waiting time was the non-streamlined process flow of the department and repetitive steps performed. These were small issues giving rise to delayed overall operations. The solutions adopted hence were simple to understand and follow. Also they were one time changes. The Written communication system was an unmanned process that successfully reduced the Per-test waiting time by 23 minutes and the Clustered Seating arrangement got the Radiologist and other people who were key personnel of the entire process flow closer and reduced redundant steps and successfully reduced the Report generation time by 48 minutes.

Hence it can be inferred that small but effective steps can make a positive impact in any department if the key problem area is well identified and worked upon.

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ANNEXURE 1

A Lean Six Sigma approach to reduce waiting and reporting time in the Radiology Department a Tertiary care Hospital in Kolkata

DATE	CASE	REQUISITION TIME	PREP TIME	GOES IN	SCAN STARTS	SCAN OVER	PATIENT GOES OUT PHYSICALLY	REPORT MADE/VERIFIED IN HIS

Gemba Walk Time Motion Study Part 1

Patient name	TEST	order time	entry into test	exit from test (t1)	ack time & date (t2)	TAT (t2-t1)
MRINMOY GHOSH	CT	09:43	10:15	11:15	10:24	00:00
USHA THAKUR	MRI	11:12	11:15	11:22	11:21	00:00

Time Motion study Part 2 Sample

Time Motion study Part 3 Sample

receiving of report by medical technologist	typing commencing	typing completion	correction completed	TAT (Typing completion - exist from test)	final signature	delivered at counter	dr. name

Time Motion study Part 4 Sample

Radiologists report writing time	In mins	Typing completion to signature	In mins	Collection and sorting	Mins	Typing time	Mins	Pretest waiting time	Mins	Post test Data System	
05:05	305	00:14	14	00:30	30	00:16	16	00:32	32	05:31	381

ANNEXURE 2

A Lean Six Sigma approach to reduce waiting and reporting time in the Radiology Department a Tertiary care Hospital in Kolkata